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AERONAUTICAL EDUCATION AND RESEARCH AT THE SWISS INSTITUTE OF TECHNOLOGY IN ZURICH

By L. Karner and J. Ackeret

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By L. Karner and J. Ackeret

The following article, which gives the details of the aerodynamic laboratory to be erected at the E.T.H. (Eidgenössische Technische Hochschule) (Swiss Institute of Technology), first appeared in a special number of the Schweizerische Bauzeitung, November 1, 1930, on the occasion of the seventy-fifth anniversary of the founding of the school. We are now reprinting this article through the courtesy of the original publishers.

Editor, Aero-Revue.

Progress in the scientific and practical fields of aviation has caused the Swiss Institute of Technology to organize lectures and practical training courses in all branches of aeronautics and to found centers of scientific research, laboratories, etc., in order to supply the government and industries with scientifically and technically trained engineers. Another purpose is to establish close contact and cooperation between theoretical research and practical aviation and to enable Swiss participation in international aeronautical progress and in the investigation of aeronautical problems of particular interest to Switzerland.

*"Forschung und Unterrichet im Flugwesen," from Aero-Revue, November 15, 1930, pp. 278-279.

The task of the aeronautical engineer is becoming more difficult with the steadily increasing introduction of scientific methods into the construction of aircraft, aviation engines, and instruments, the production of materials, planning and installation of air-traffic equipment, etc. For the purpose of adequately educating engineers for government service as civil-air-traffic inspectors or defense experts, they must become thoroughly acquainted with the scientific and practical problems considered. Besides, certain considerably developed aeronautical industries require a rising generation of properly trained engineers, acquainted with modern research and working methods and capable of effectively promoting aeronautical progress. Among the Swiss industries interested in aeronautical development are the aluminum industry (A.I. Co., Neuhausen), the engine industry (Schweiz. Lokomotiv-und-Maschinen Fabrik Winterthur, Ad. Saurer in Arbon, etc.), the magneto industry (Scintilla Co. in Solothurn) and, particularly, workshops for aircraft construction. The Swiss Aircraft Factory at Thun not only fills part of the government orders, but has also exported during recent years a considerable number of excellent airplanes of all-duralumin construction. The A. Comte Aircraft Factory at Horgen is well known for its passenger and training airplanes, as likewise the Dornier Aircraft Company, at Altenrhein.

The purpose and aims of the E.T.H. for the development of aviation being thus outlined, the installations for instruction

and scientific research will now be described. The courses of instruction comprise lectures on aerodynamics, aerostatics, aircraft and engine construction, light metals, wireless telegraphy, general meteorology, aircraft instruments and accessories, technical problems of air traffic, air-traffic economics, and politics. A considerable number of these courses include practical exercises in drafting rooms and laboratories. Collections of models and airplane parts, drawings, plates, etc., are also used to supplement the instruction. A further welcome addition is the aeronautical seminar briefly described at the end of this report.

Institutes and laboratories for scientific research are now being developed in connection with the engine laboratory of the E.T.H. The most important data on the proposed installations are given below.

The chief means of research in the aerodynamic laboratory is a free-jet wind tunnel (Fig. 1). The tunnel was designed to enable the use of all the available space. An elliptical section, 2 m (6.56 ft.) wide by 1.5 m (4.92 ft.) high, was therefore adopted for the open working portion in which airplane, wing and fuselage models, etc. are tested, more space being required in the horizontal width so as to provide sufficient margin on all sides between the model and the limits of the air stream. Calculation shows that airplane models of 1.2 m (~~39.37~~ 47.24 in.) span can be satisfactorily tested in the proposed air stream.

The drive consists of a Leonard gear with special speed control, a D.C. motor, and a fan with guide mechanism. The air flows from the blower into the closed portion, is guided by vanes, and reaches the open portion at a maximum speed of 150-160 km/h (93-99 mi./hr.). It is then drawn into the exit cone and led back to the blower. All the tunnel parts, such as the guide vanes, exit cone, etc., are now undergoing special tests for the purpose of reducing the flow losses and thus increasing the efficiency of the tunnel.

The maximum power is 200 hp, while for standard tests the power is about 100 hp. For propeller tests, a smaller entrance cone of circular cross section, in which wind velocities of 230 km/h (143 mi./hr.) can be reached, is provided. The models are suspended from a six-component balance by means of which all the forces and moments acting on the model can be measured. All possible positions of flight, such as side slipping, inverted flight, etc., can be thus investigated. Extensive installations are also planned for investigating the effect of the propeller slipstream on the control surfaces and for pressure-distribution measurements for different cases of loading. All the details of the dangerous spin can also be studied.

Provision has also been made for studying problems in other fields of technical activity. It is comparatively easy to use the installations for wind-pressure measurements on bridges, vehicles, and buildings. Provision is made for measurements on

individual wing sections and airfoil gratings, which are of the highest practical as well as scientific importance in turbine construction (Kaplan turbines).

About one hundred wind tunnels are now in operation, mostly in the large countries, but the accomplishments of Poland, Spain, etc., in this field likewise deserve consideration. Switzerland is participating none too soon in this work. The government authorities have now demonstrated their farsightedness, however, by granting appropriations for the simultaneous construction of another wind tunnel which is only secondarily designed for aeronautical purposes (Fig. 2). The completely enclosed air stream, although not very large, develops unusually high velocities. According to calculation, a velocity of 500 m/s (1640 ft./sec.) or approximately 1800 km/h (1120 mi./hr.) is expected, - a speed never yet reached even by the fastest airplanes, but frequently attained in steam turbines and turbocompressors. While air may be considered fairly incompressible at flow velocities not exceeding 150 m/s (492 ft./sec.), its compressibility becomes very apparent in the neighborhood of the velocity of sound and completely changes the laws of flow. The problem of compressibility is of considerable importance in giant turbine construction, but has not yet received the attention it deserves. This field requires thorough investigation, in order to promote the work to which Professor A. Stodola has devoted much of his lifetime.

Two large turbocompressors will be set up in cooperation

with the thermodynamic division. On account of the unusually large volumes of air, one of the compressors is of quite novel design, with axial flow. A diagrammatic view of the installation is shown in Figure 2. The blowers are operated jointly or separately by a three-phase A.C. turbomotor of approximately 2000 hp. The previously dried air flows through the entrance cone into the experimental section, where guide vanes, exit cones and other objects are mounted. Forces and pressures exerted on these objects are measured by balances and manometers. It is, of course, possible to work at lower velocities. Direct observation of the flow phenomena at ultra-sonic velocities is afforded by the Töpler-Mach striae method. The whole tunnel can be exhausted in order to attain maximum velocities. Special measures are required for the removal of the enormous amounts of heat produced during the test. In this connection all important parts are subjected to preliminary model tests.

Engine drives can be tested in the new engine laboratory. Actual brake tests of powerful engines must be made at the aviation field, the task of the laboratory (thermodynamic division) being thus confined, aside from the testing of small engines, to more general and detailed investigations. These investigations chiefly involve problems of cooling, ignition, lubrication, carburetion, etc., as well as critical crank-shaft vibrations. The development of aircraft engines of the Diesel type involves further difficult problems.

The quarters and installations of the static aeronautical division are also developed jointly with those of the engine laboratory. Even simple cases of static and dynamic aircraft strength calculation involve difficult questions and problems, which cannot be fully solved by purely mathematical methods, but require exhaustive scientific tests and measurements. Many of these problems await their solution and represent tasks of great, if not vital, importance to the development of aviation. Among these problems are airplane vibrations, wing torsion, stress distribution in streamlined sections under tension or compression, buckling of thin-walled parts, etc. These examples indicate the great variety of problems and necessary corresponding scientific investigations. Since the lecture courses in aviation will now be so supported as to give the rising generation of aeronautical engineers a proper scientific training, the institute must be equipped with up-to-date apparatus for the application of the different methods of static and dynamic tests. The institute must, in the first place, do scientific work and place the results at the disposal of its students. It may, however, also work on problems submitted by government authorities, aviation companies, aircraft factories, etc., and thus help these organizations by special investigations. The institute has already begun some of its work which does not require special equipment, and has made several interesting investigations, on which special reports will soon be published.

Finally, the purpose of the above-mentioned aviation seminar is to establish close contact and cooperation between theory and practice. Lectures and discussions will be arranged at regular intervals at the E.T.H. They will be open to all persons interested in the subjects discussed, which will include all important aeronautical problems of the day. Means for a free exchange of views is thus afforded, together with the opportunity to learn the needs of the industry, on the one hand, and the latest results of domestic and foreign aeronautical research, on the other hand.

Translation by
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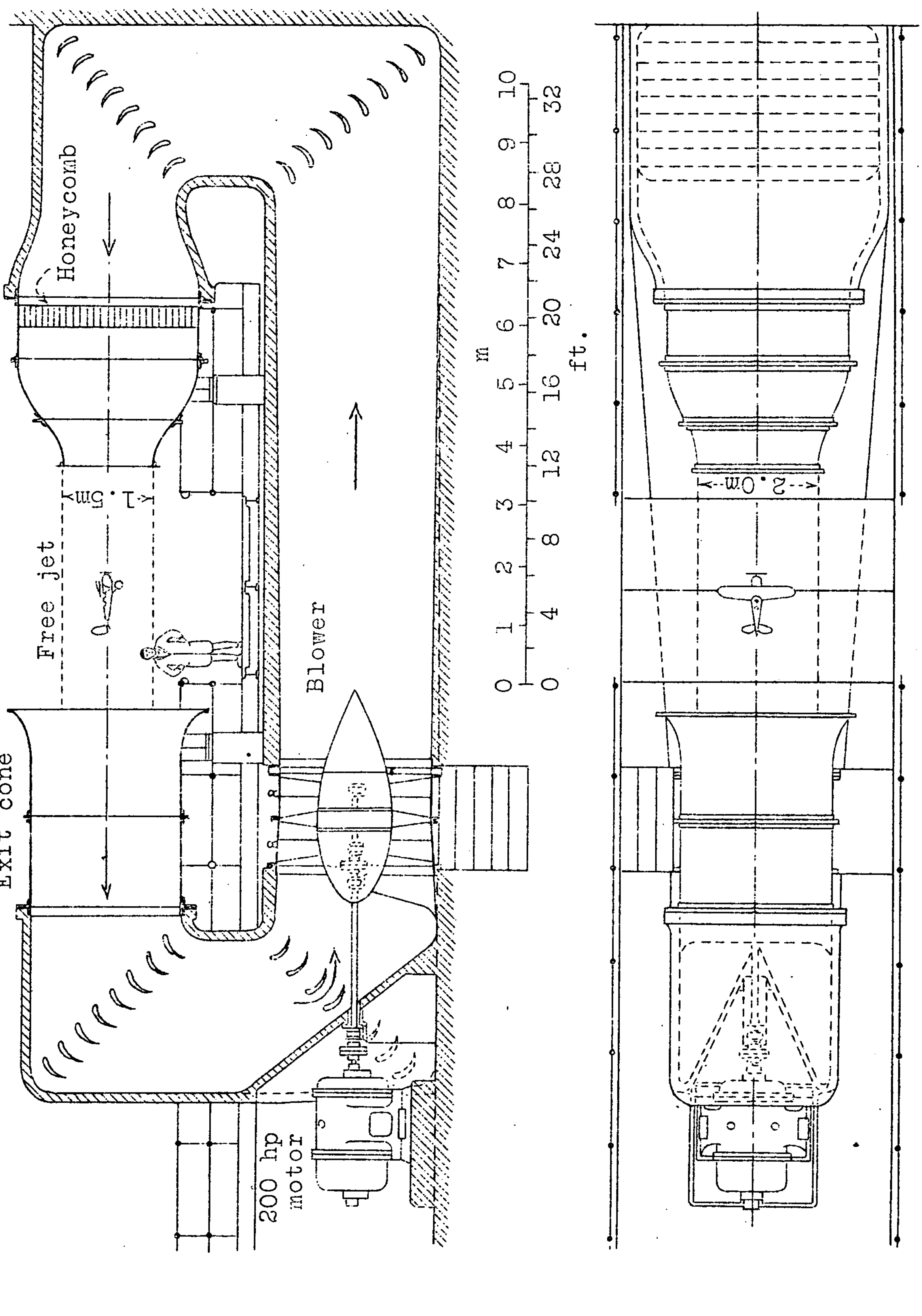
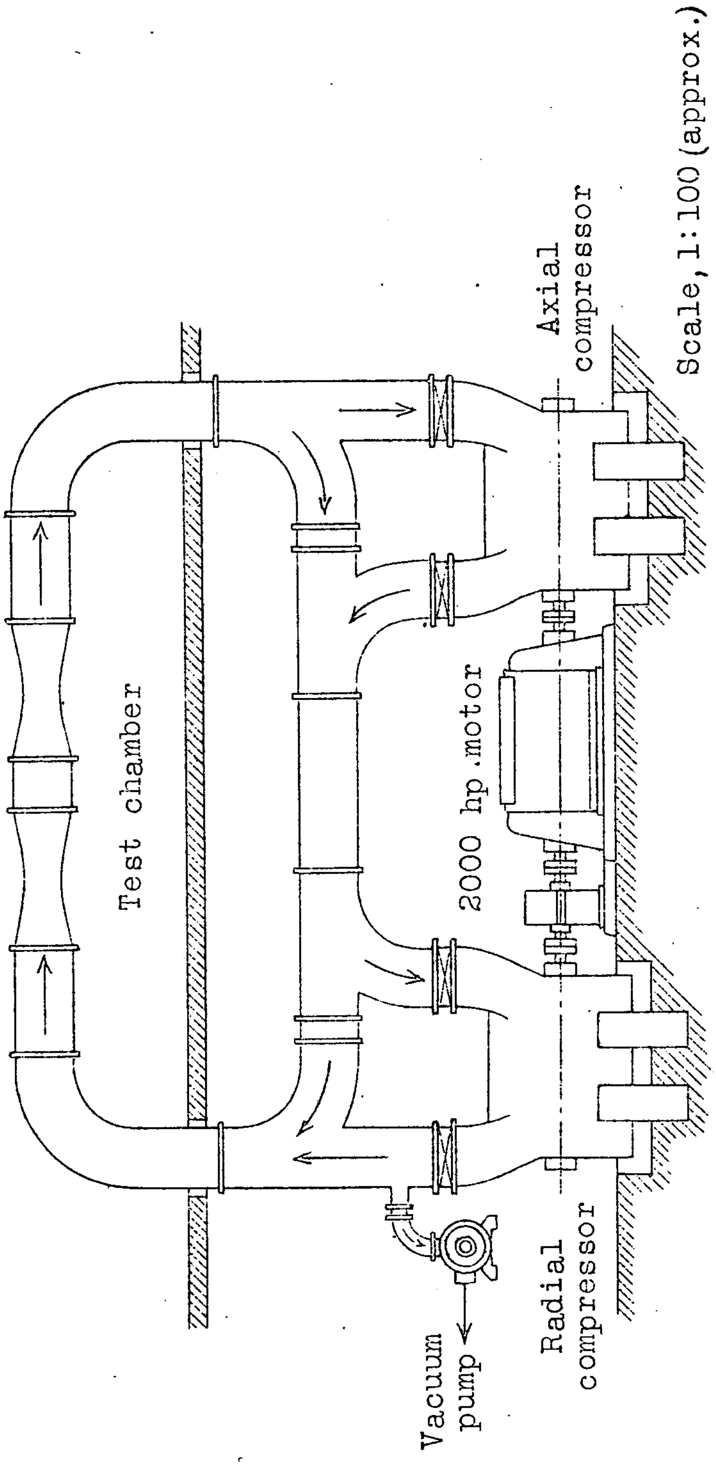


Fig. 1 Free-jet wind tunnel. Longitudinal section and plan.



Closed-circuit wind tunnel

Fig. 2